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Signed R. Mahoney

Dated 29 October 2004

Patents Form 1/77

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240CT03 E847087-1 002888
P01/7700 0.00-0324823.4

THE PATENT OFFICE
J
24 OCT 2003
NEWPORT

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference

XLT 93B

24 OCT 2003

0324823.4

2. Patent application number
(The Patent Office will fill this part in)

NEW APPLICATION

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

HEAD PHILIP
GIBB HOUSE
KENNEL RIDE
ASCOT
BERKS SL5 7NT

Patents ADP number *(if you know it)*

07920812001

If the applicant is a corporate body, give the country/state of its incorporation

UNITED KINGDOM

4. Title of the invention

A Method of Abandoning a Well

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

HILLGATE PATENT SERVICES

NO. 6 AZTEC ROW
BERNERS ROAD
LONDON, N1 0PW

Patents ADP number *(if you know it)*

05953112002

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

Number of earlier UK application	Date of filing *(day / month / year)*

8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?

NO

Answer YES if:

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.

Otherwise answer NO (See note d)

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form	—
Description	7
Claim(s)	—
Abstract	—
Drawing(s)	9 + 9

10. If you are also filing any of the following, state how many against each item.

Priority documents	—
Translations of priority documents	—
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	—
Request for a preliminary examination and search (Patents Form 9/77)	—
Request for a substantive examination (Patents Form 10/77)	—
Any other documents (please specify)	—

11. I/We request the grant of a patent on the basis of this application.

Signature(s) Hillgate Patent Service Date 23/10/03

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

SOPHIE MAUGHAN 020 7704 9997

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Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered YES in part 8, a Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) Part 7 should only be completed when a divisional application is being made under section 15(4), or when an application is being made under section 8(3), 12(6) or 37(4) following an entitlement dispute. By completing part 7 you are requesting that this application takes the same filing date as an earlier UK application. If you want the new application to have the same priority date(s) as the earlier UK application, you should also complete part 6 with the priority details.

A Method of Abandoning a Well

Over the past 20 years or so a large number of offshore structures have been constructed which are now or will soon be exhausted and will need to be abandoned. These offshore structures may comprise production platforms which are either steel or concrete structures resting on the sea bed or floating platforms. Numerous conduits are connected to these offshore structures to carry the various fluids being gas, oil or water etc., which are necessary for the production of oil and/or gas from the well.

In abandoning a well, consideration has to be given to the potential environmental threat from the abandoned well for many years in the future.

In the case of offshore structure there is usually no rig derrick in place which can be used to perform the required well abandonment procedure. Therefore it is typically necessary to install a new derrick or alternatively a mobile derrick can be positioned above the well. This requirement adds considerable expense to the to the task of abandoning the offshore well, compared to a land based well.

A typical production well will comprise a number of tubular conduits arranged concentrically with respect to each. The method of abandoning the well which is presently known in the art involves the separate sealing of each of the concentric conduits which requires a large number of sequential steps.

In the abandonment method known in the art the first step is to seal the first central conduit usually by means of cement or other suitable sealant. The first annular channel between the first and second conduits is then sealed and the first central conduit is then cut above the seal and the cut section is removed from the well.

The second annular channel between the second and third conduits is then sealed and the second conduit cut above the seal and the cut section is removed from the well.

This process is repeated until all the conduits are removed. The number of separate steps required is typically very large indeed and the number of separate operations is five times the number of conduits to be removed. This adds considerably to the cost of the well abandonment due to the time taken and the resources required at the well head.

It is the purpose of the present invention to provide a method of abandoning a well which avoids the disadvantageous and numerous operations which are required by the existing known methods. This will greatly reduce the costs of safely abandoning a well. It is a further objective of the invention to provide a method of abandoning a well without the requirement of a rig which involves significant expense particularly in sea based wells.

It is a further advantage of the invention to isolate all the conduits and annuli with no return of the well bore or annular fluids to the surface. Additionally if required all tubing and casing can remain in the well. Further more the method of abandonment of the well will comply with all the regulatory guidelines for the isolation of a well.

According to the invention for the method of abandoning a well, said well comprising at least two concentric conduits comprising at least one annular channels there between, comprises the steps of:

a. providing a perforation in the innermost conduits,

b. pumping out the fluid from the annular channel,

d. inserting sealing material in the annular channel.

Preferably the fluids in the well are pressed down into the formation. Preferably a plug is provided at the lowermost part of the innermost conduit said plug provided with one a one way valve to permit fluids to flow downwards but to prevent the upwards return of fluids.

Thus by means of the method according to the invention the number of operations required is greatly reduced thus resulting in a considerable reduction in the cost of carrying out the well abandonment.

The following is a more detailed description of an embodiment according to invention by reference to the following drawings in which:

Figure 1 is a side view of a typical subsea well showing a vessel situated over it and with a well intervention package attached.

Figure 2 is a plan view of the multi barrel storage and launching assembly, located above the wellhead and below the blow out preventors.

Figure 3 is a side view of the wellhead, with a well intervention system connected and a tool assembly being lowered from the vessel above.

Figure 4 is a side view of the wellhead, with a well intervention system connected and a tool assembly installed in the pressure vessel (lubricator) section of the well intervention package.

Figure 5 is a cross section of a well showing the typical components and there relative depth.

Figure 6 shows the same cross section of the well as the figure above, but with a tool assembly lowered to its tailpipe

Figure 7 shows the same cross section of the well as the figure above, displacing fluid into the reservoir section and lowering an electric pump

Figure 8 shows the same cross section of the well as the figure above, the lower tubing and tubing annuli evaculated of fluid by the electric pump.

Figure 9 shows a cross section of the umbilical power cable

Figure 10 Shows the lower voids filled with sealing material

Figure 11 shows the electric pump and hole making system moved up the well and new holes perforated through all the sections of casing

Figure 12 shows all the annuli perforated, voided of fluid by allowing to flow to the sump below and by using the electric pump, and finally filled with sealing material

Referring to the figures in more detail, Figure 1 to 4 shows the well intervention package. This consists of a wellhead connector adaptor 10, an optional wellhead plug retrieval and plug launcher carousel 11 fitted directly above this the blow out preventors 12 then the high pressure wellbore extension (more commonly know as the lubricator) 13 A funnel guide 14 provides easy access for the tools when lowered from the vessel 15. Guide lines are show 16, but are not essential. A tool assembly 20 is prepared on the vessel and lowered on an umbilical 21. It is also lowered with the

dynamic umbilical seal 22 a guide means 23 and a method of docking and retaining itself 24 into an internal profile 25 at the top of the lubricator 13 The wellhead plug 30 ensures the well is safe for normal production operations, but can be removed to enable the well to be accessed. A tool can either be activated from the tool carousel 11 or lowered from the vessel. In either case the plug can be stored in an empty barrel of the tool carousel. This saves considerable tripping time for the operating tool 20.

Figure 5 to 12 shows the well abandonment process in greater detail. The main objectives are to Isolate all zones and casing annuli with multi interval 100% permanent seal, prohibit the return of well bore hydrocarbon fluids to surface, eliminate the need to pull out of the well the production tubing and disposal of it. How this is achieved is described as follows.

Fig. 5 shows a well which is required to be abandoned and made safe by the method and apparatus described herein. If required, to ensure a good sealing, material may be placed in the annular area 40 around the tailpipe, then a tailpipe seal 41 is lowered on an umbilical and it is landed in a tailpipe nipple (not shown) to hold it in place. This is not essential, but it provides an ideal sealing and anchor point.

As shown in fig. 6 a seal assembly 39 is provided includes a seal at its lower end which plugs the end of the production tubing 30. The seal assembly includes a hole making system such as a perforating charge 42. This is used to make hole(s) 43 in the tailpipe to permit the flow of the existing well fluids therethrough. The tailpipe seal also has a dual check valve 45 to provide a means permitting flow from the production tubing into the lower part of the well and of preventing fluid from flowing back into the production tubing. This dual check valve is preferably mechanical, which may in its simplest form be a spring loaded ball biased against a sealing seat. The seal assembly 39 is lowered into

position by means of a conveyance tool 50, which is provided on the end of an the umbilical 49. After the seal assembly is fixed in position the umbilical 49 and conveyance tool 50 are recovered back to surface.

Referring now to Fig. 7 a pump assembly 50 is then lowered down the main bore production. The pump assembly includes a pump 53 below which is provided tube holing means and below the holing means well sealing material 52 is provided. At the lowermost end of the well sealing material a bottom plug 51 is provided. The pump assembly is forced down the production tubing by the pressure of a displacement fluid provided above the pump assembly. The displacement fluid could be seawater or even nitrogen. The bottom plug 51 seals against the internal wall of the production tubing so that the contents of the production tubing 55 are then displaced back into the lower part of the well and into the reservoir through the reservoir perforations 56. When the pump assembly has been completely pushed down to the check valve 45, the well sealing material has passed through the plug assembly and into the lowermost part of the well. This sealing material cures in time and provides a permanent seal of the formation.

Holes are made in the production tubing 60, by the holing means. This could be any suitable holing means such as by using perforating charges 61. This is shown in fig. 8. The pump is now activated and the pump causes the displacement fluid in the production tubing 63 to be pumped upwards through the bore in the umbilical 64 and out of the well and the fluids in the annulus 62 correspondingly drain into the production tubing and are similarly pumped out of the well up the umbilical 64 until all the fluid in annulus 62 is removed. There will be a small remainder of fluid in the annulus below the level of the perforations 60..

Whilst in this embodiment the plug, sealing, holing and pumping actions are carried out in that particular sequence using a single

pump assembly tool, it is also possible to use separate tools for the separate steps and variations to the sequence.

For example, the sealing material could be provided after the holing of the production tubing. The fluids could then be pumped downwards into the reservoir section also instead of out wards to surface, before a sealing material is placed behind them. This would avoid the need to make separate arrangements for the disposal of the fluids pumped out.

Referring back to the embodiment shown in the drawings, and in particular Fig. 10 Once chambers 61 and 62 have been voided of fluids, the pump can be moved up the hole and sealing material pumped down the production tubing annulus 62. This will equalise in both the tubing annulus and tubing ID at equal levels and form a perfect 2nd barrier 70 to the reservoir.

Subsequently, at a suitable depth, , a new set of perforations 80 are made and the residual mud in chambers 81 and 82 is allowed to drain into the sump 83 and 84. Preferably the next set of perforations is made at a depth where as many casing can be perforated as possible.

If the drained fluid rises above the pump 53, then the excess fluid can be pumped out the well via the umbilical. Finally, sealing material 90 can be pumped into any of the voided chambers 91 or 92 and fill all the voided chambers 93 and 94 via the equalisation holes 95. The wellhead and multi casing string could then be safely removed, for example by abrasive jet cut off of the conductor below the mud line and safely recovered back to the vessel.

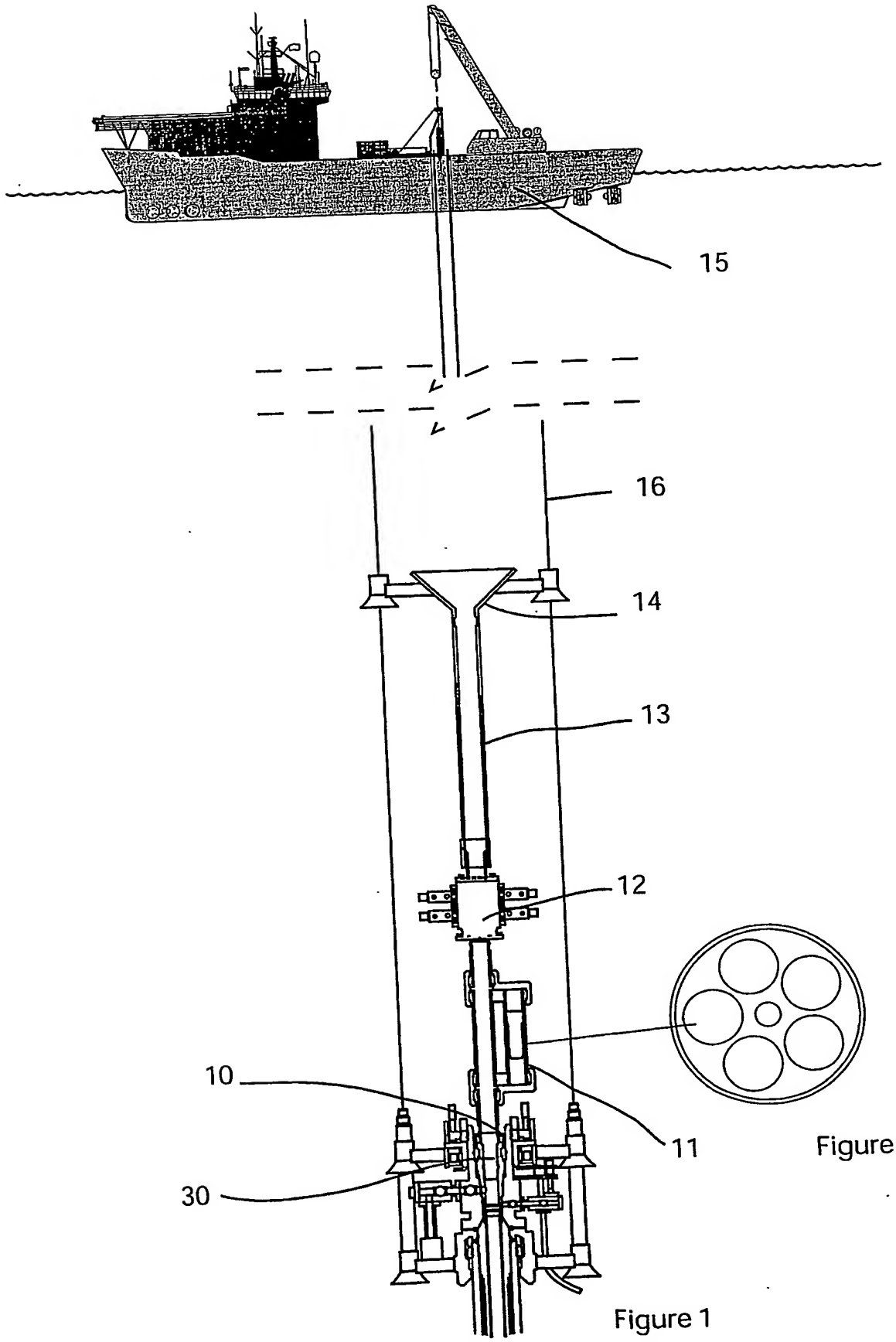

Figure 2

Figure 1

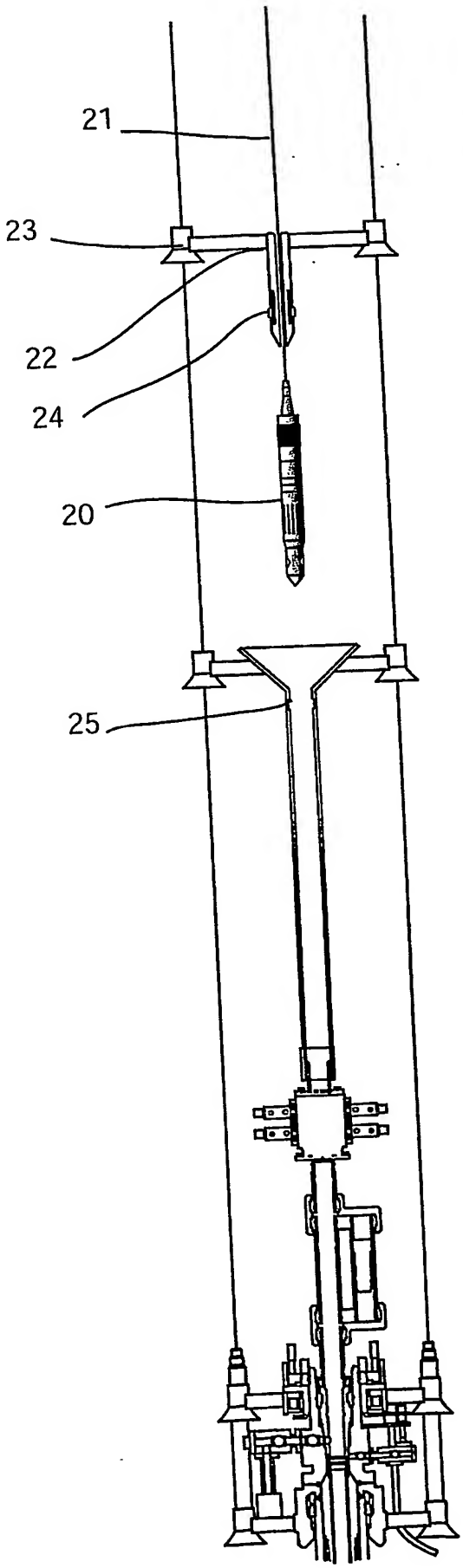

Figure 3

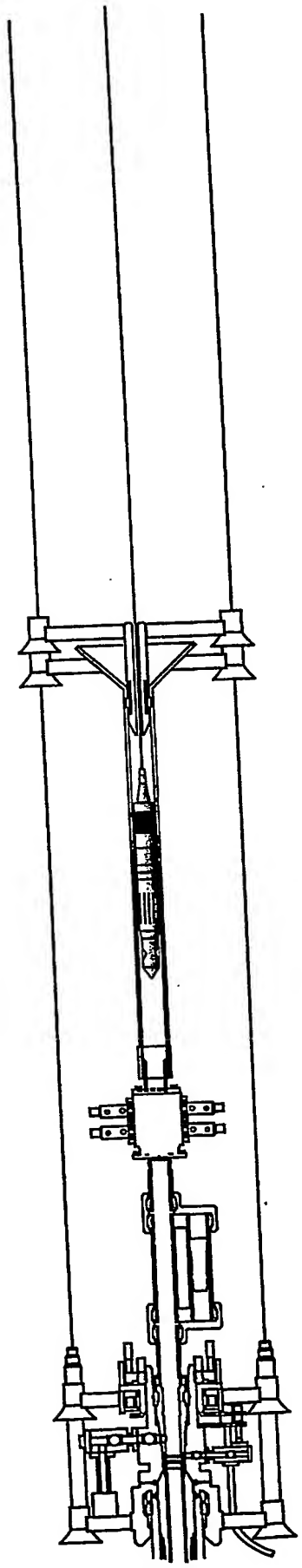

Figure 4

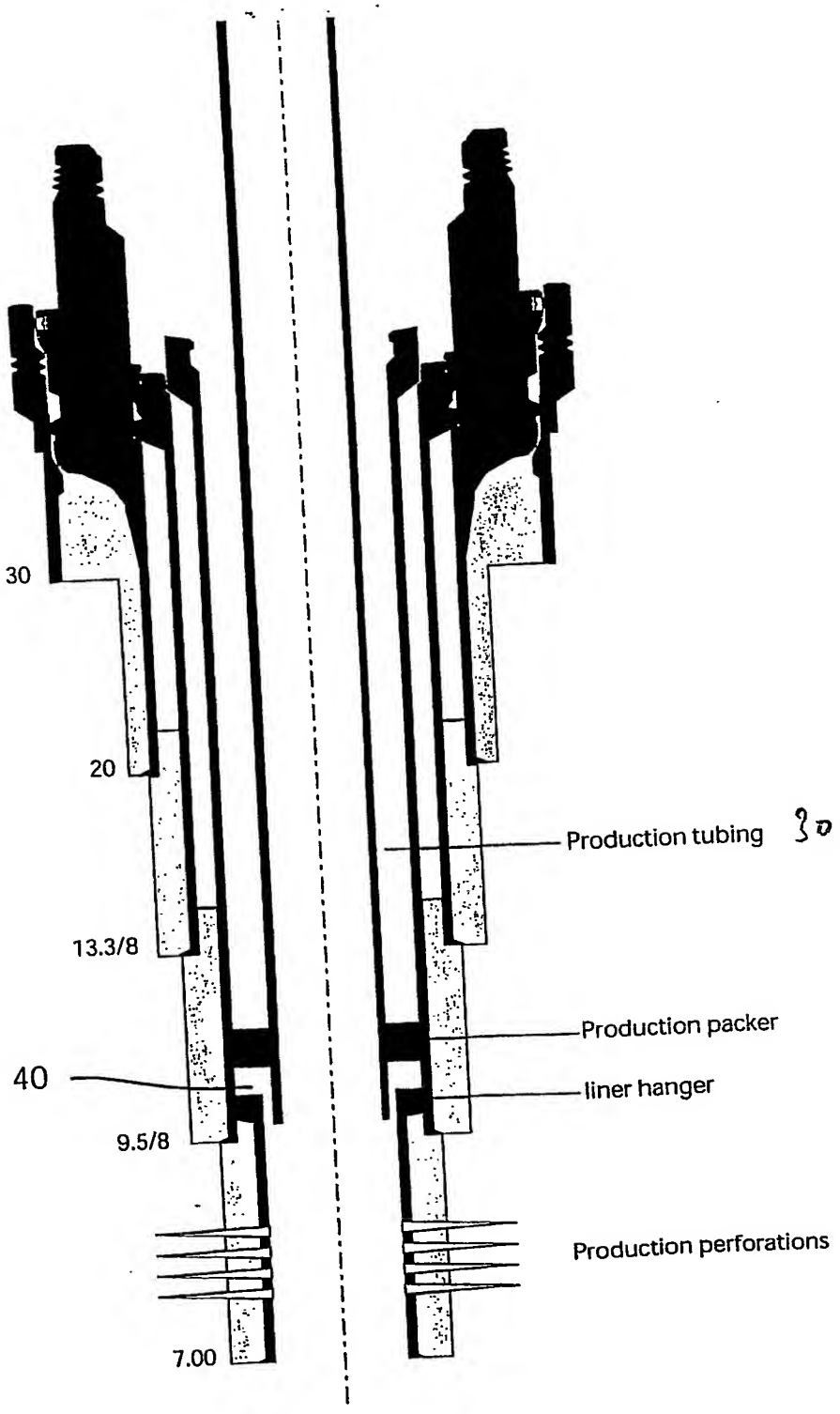
30
20
13.3/8
40
9.5/8
7.00
Production tubing
Production packer
liner hanger
Production perforations

Figure 5

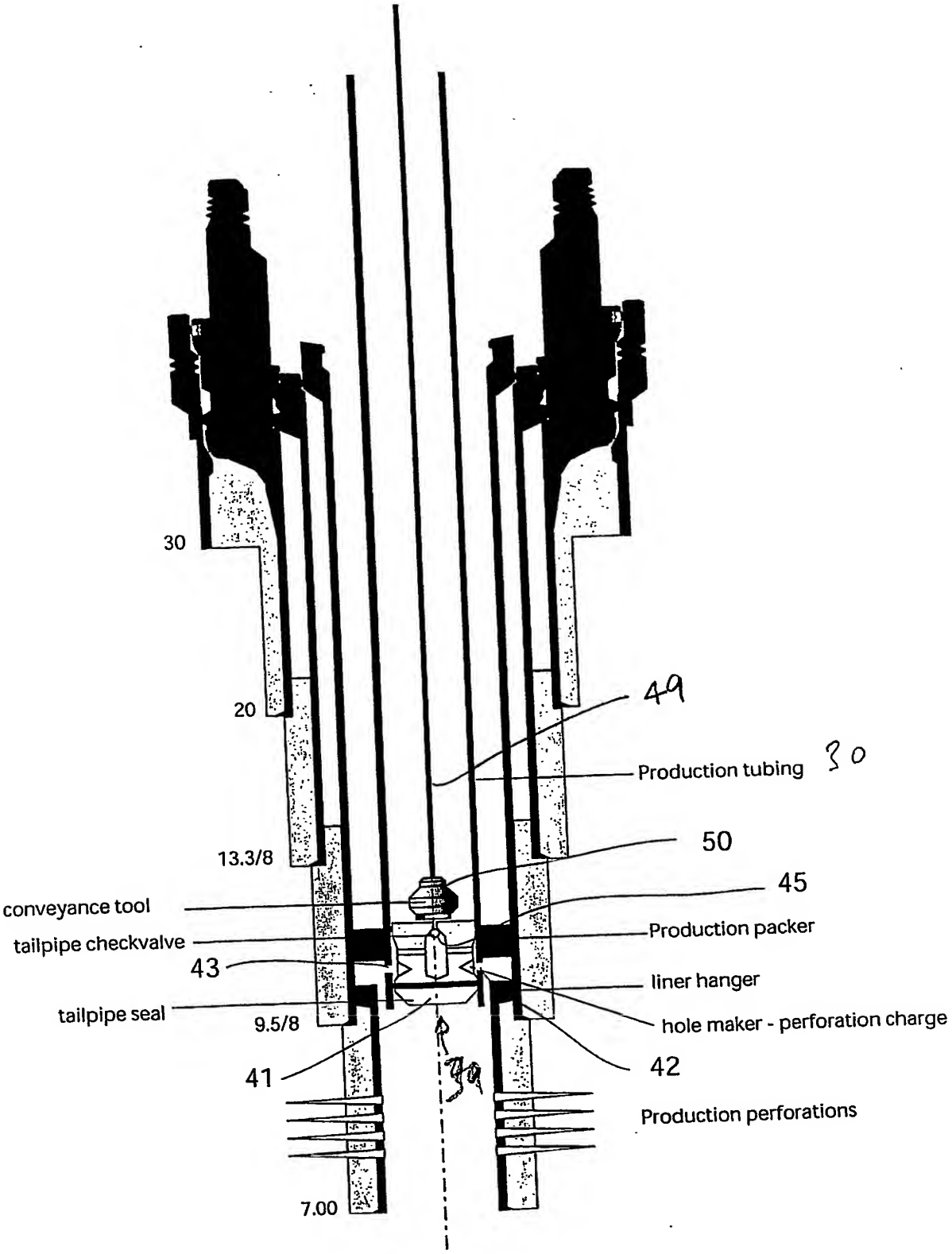
30
20
49
Production tubing
30
13.3/8
50
45
conveyance tool
Production packer
tailpipe checkvalve
43
liner hanger
tailpipe seal
9.5/8
hole maker - perforation charge
41
42
39
Production perforations
7.00

Figure 6

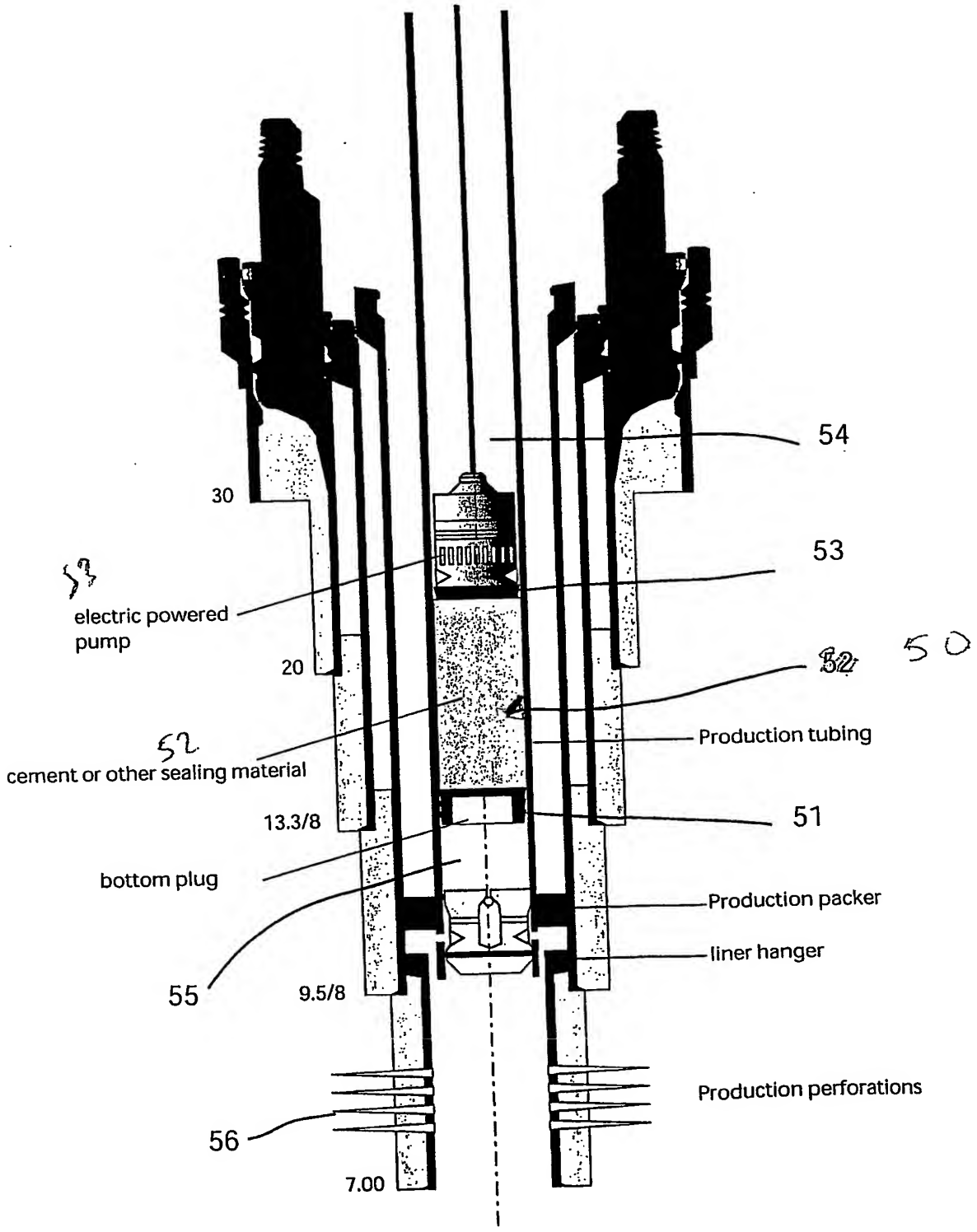
54
30
53
electric powered pump
20
52
50
cement or other sealing material
Production tubing
13.3/8
51
bottom plug
Production packer
liner hanger
55
9.5/8
Production perforations
56
7.00

Figure 7

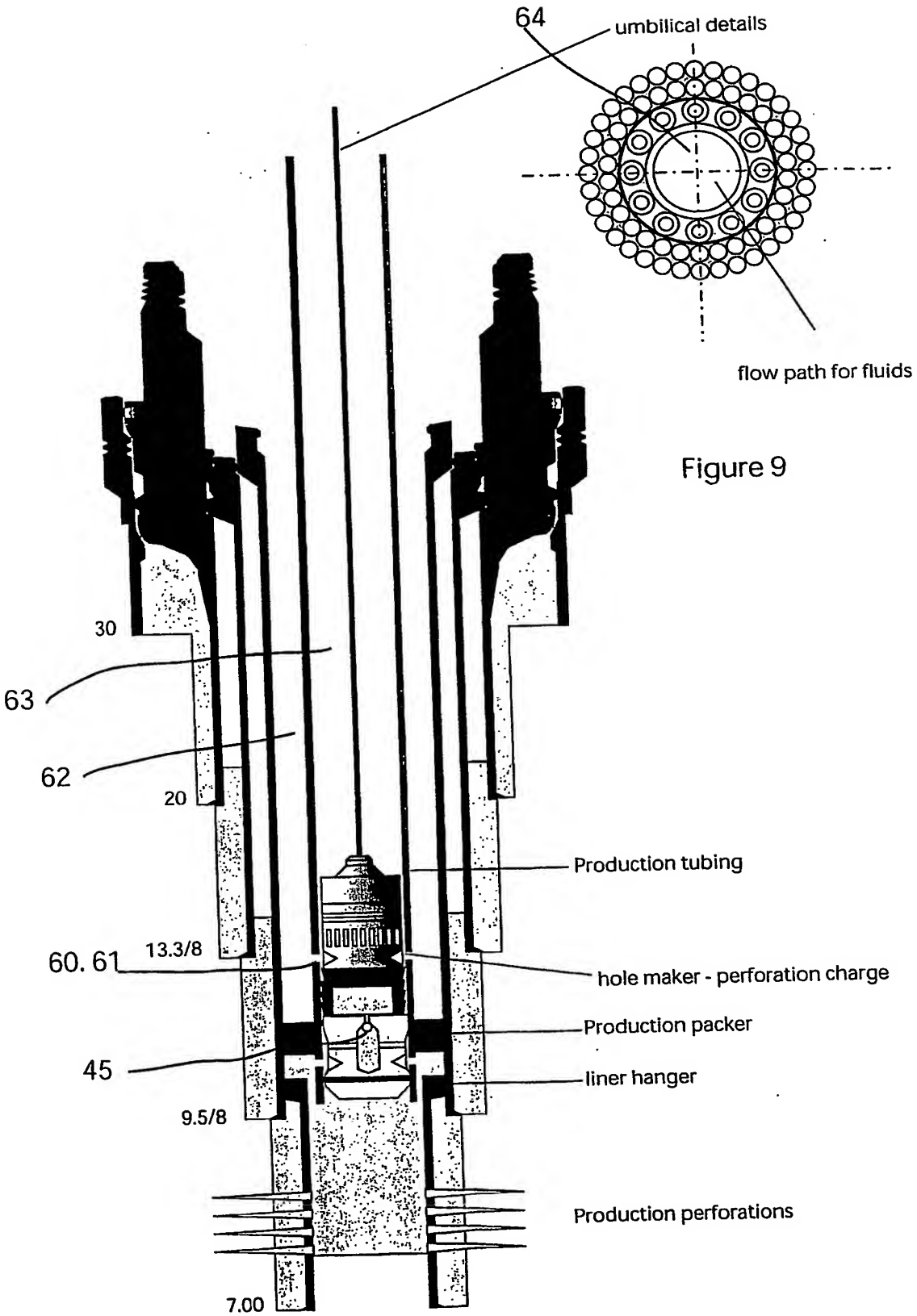

Figure 9

Figure 8

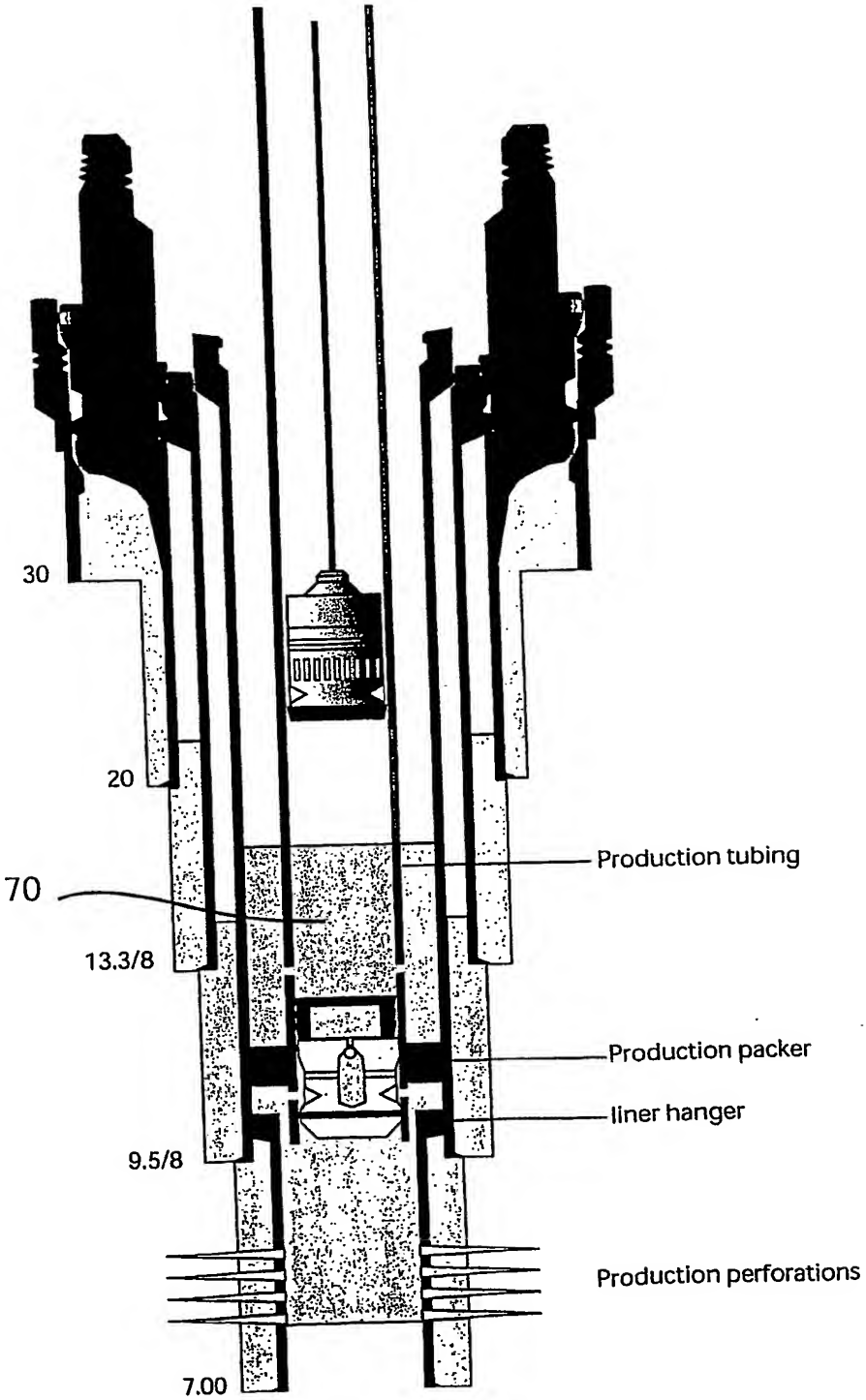
30
20
70
13.3/8
9.5/8
7.00
Production tubing
Production packer
liner hanger
Production perforations

Figure 10

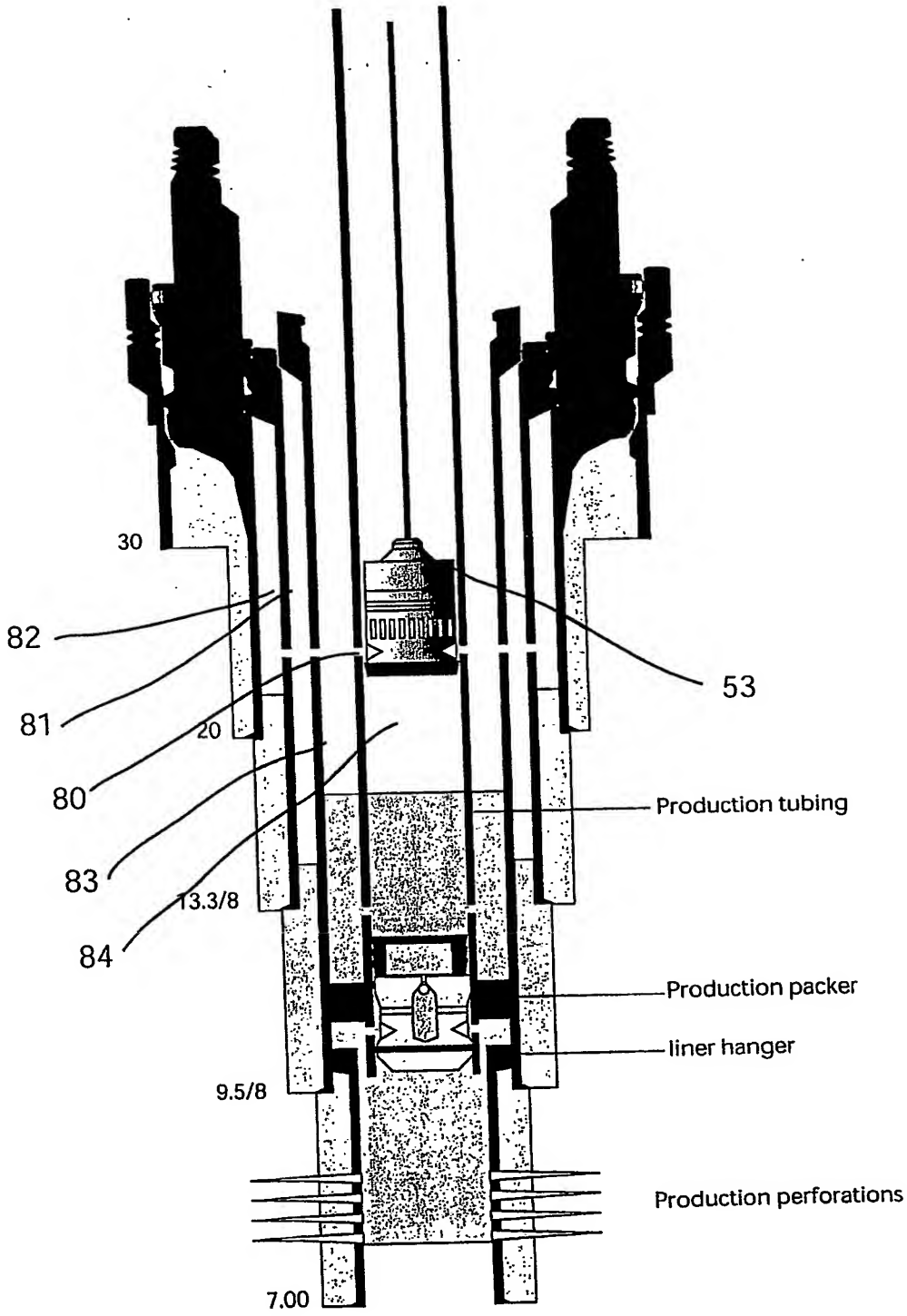
30
82
81
80
83
84
20
13.3/8
9.5/8
7.00
53
Production tubing
Production packer
liner hanger
Production perforations

Figure 11

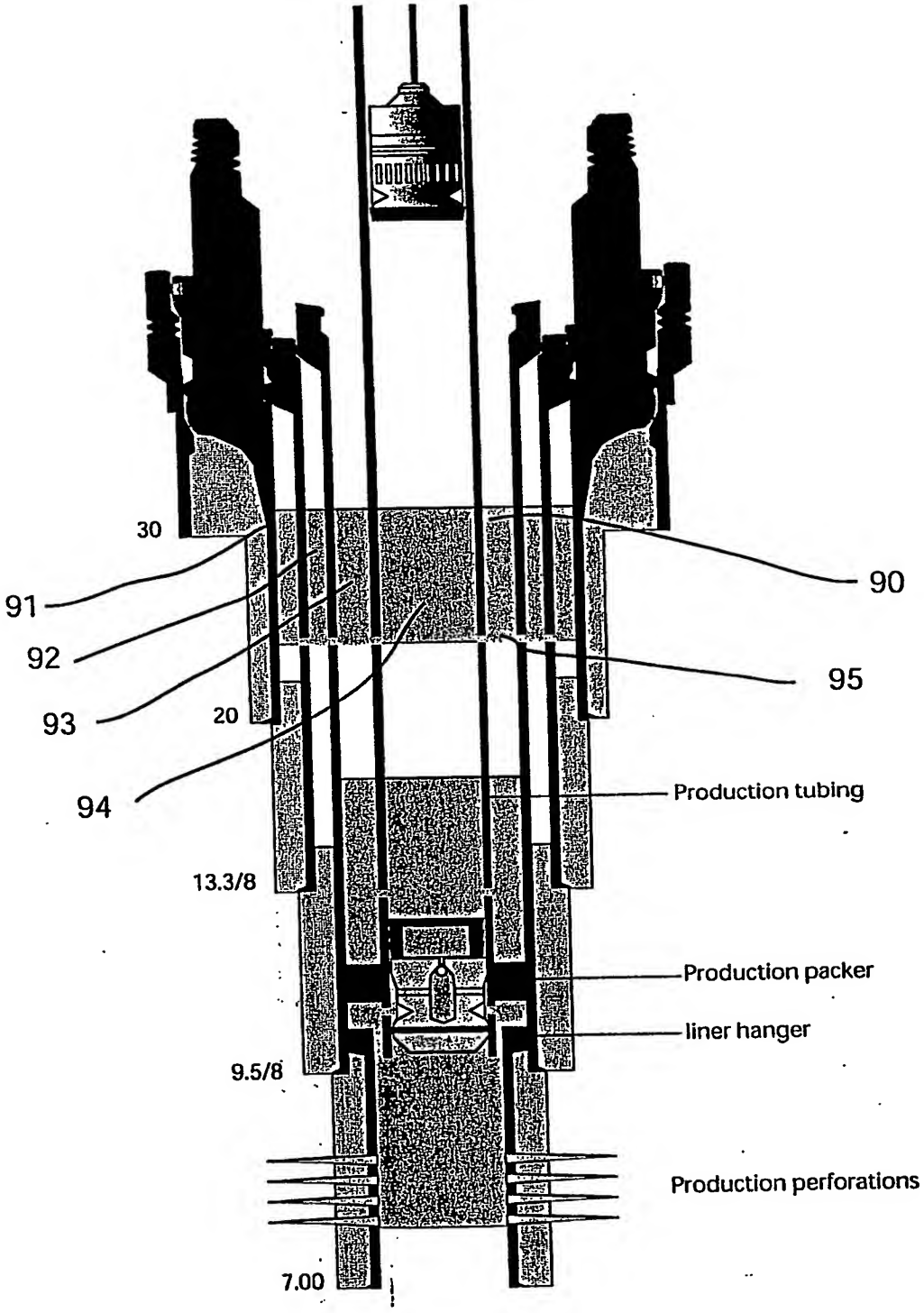
30
91
92
93
94
90
95
20
Production tubing
13.3/8
Production packer
liner hanger
9.5/8
Production perforations
7.00

Figure 12